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MEASUREMENT OF TWINS[1]

THE following is a summary of the results of a study of the comparative importance of original nature and training in the case of fifty pairs of twins. A detailed account of the investigation will be published shortly.

The Resemblances of Twins and of Siblings

From the information at hand, which is not so satisfactory as information I hope to obtain during the next few years, the resemblance of twins in mental traits is roughly twice that of ordinary siblings;[2] according to the actual figures of my measurements of siblings, more than twice. I have reason, however, to believe that the correlation coefficients obtained for siblings are affected by constant errors which make them too low; namely, the selection of mentally unlike pairs by the conditions of the methods of obtaining siblings and the absence of suitable data to make sufficient correction for attenuation. Table 1 gives the facts.

I use the words *'resemblance of'* and *'likeness of'* as synonyms for *'coefficients of correlation between.'* A resemblance of .50 means, then, a Pearson correlation coefficient of .50. I use the terms A test, word test, misspelled word test, opposites test, addition and multiplication to mean the tests, or at times the abilities measured by the tests, to describe which would take too much space.

TABLE 1

The resemblances of twins and siblings compared

	Coefficients of Correlation	
Ability	Twins	Siblings
A test	.69	.32
Word test	.71	.29
Opposites test	.90	.30

I give for siblings the obtained results. Since the correction for attenuation had to be made in an imperfect form, the true resemblances are probably somewhat higher, but not over .40.

The Resemblances of Young and of Old Twins

The older twins show no closer resemblance than the younger twins, and the chances are surely four to one that with an infinite number of twins tested the 12–14 year olds would not show a resemblance .15 greater than the 9–11 year olds. The facts are given in Table 2.

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[1] The investigation here reported was made possible by a grant from the Esther Herrman Research Fund of the New York Academy of Sciences.

[2] Karl Pearson has pointed out that the word *sibling* is a convenient term to denote children of the same parents.

TABLE 2

The resemblances of young and old twins compared

	In Corrected Coefficients		In Raw Coefficients	
	Twins 9–11	Twins 12–14	Twins 9–11	Twins 12–14
1) A test	.66	.73	.58	.67
2) Word test	.81	.62	.62	.49
3) Misspelled word test	.76	.74	.76	.74
4) Addition	.90	.54	.83	.46
5) Multiplication	.91	.69	.81	.53
6) Opposites	.96	.88	.79	.78
Marks in 1), 2) and 3) combined			.71	.69
Marks in 4), 5) and 6) combined			.90	.75
Averages	.83	.70	.75	.64

The Resemblances in Traits Little and in Traits Much Subject to Training

The variations in the closeness of resemblance of the twins in the different traits show little, and possibly no, direct correlation with the amount of opportunity for environmental influences. The traits most subject to training (addition and multiplication) do show closer resemblances than the traits least subject to training (the A test and word test); but on the other hand show less close resemblances than the traits moderately subject to training (the misspelled word test and opposites test). The hypothesis that the true resemblance varies in amount *inversely* with the amount of opportunity for environmental influence would not be irreconcilable with the facts, and the hypothesis that the differences between the different traits are due to chance (including in that term the variable errors of the measurements and the possibility of the unequal inheritance of different traits) is the most probable of all. The difference between the traits most subject and those least subject to training is no greater than the median difference between any one trait of the six and any other. Surely there is no evidence here of any large contribution from similarity of training to similarity of achievement. The facts are given in Table 3.

The Resemblances in Mental Traits Compared with the Resemblances in Physical Traits

It is highly probable from the facts so far given that the similarity of twins in ancestry and conditions of conception and birth accounts for almost all of their similarity in mental achievement,—that only a small fraction of it can be attributed to similarity in training. On general principles it is also highly probable that similarity of ancestry and conditions of conception will produce equal similarity in original physical nature and in original

TABLE 3

The resemblances of twins in traits little and in traits much subject to training

	Coefficients of Correlation	Averages
1) A test	.69	.70
2) Word test	.71	
3) Misspelled word test	.80 (?)[3]	.85 +
6) Opposites test	.90	
4) Addition	.75	.795
5) Multiplication	.84	
Marks in 1), 2) and 3) combined	.70 (raw)[4]	
Marks in 4), 5) and 6) combined	.82 (raw)[5]	

mental nature. Certain resemblances in original physical nature are in all probability neither increased nor decreased by such similarities and differences of home training as act upon twins and non-related children, respectively, within a group such as ours; *e. g.,* resemblances in cephalic index, ratio of height sitting to total height, eye color and hair color. Other resemblances in original physical nature are so increased and decreased slightly and perhaps not at all; *e. g.,* circumference of head, length of head, width of head, length of forearm and length of finger joints.

If, then, the resemblances of twins were almost entirely due to original nature, we should expect them to be only slightly in excess of the resemblances in physical traits. The existence of the latter as a fact may properly be taken as a partial verification of the former as a general hypothesis. The evidence of its existence is given in Table 4.

Summary and Criticism

These facts prove that among one hundred twins living and attending school in New York City in 1903–4, the mental resemblances of a twin pair are about twice as great as those of a pair of siblings similarly chosen, are as great or nearly as great in the case of the younger as of the older half of the group, are as great or nearly as great in the case of the A, word, misspelled word and opposites tests as in the case of addition and multiplication, and are only slightly, if at all, greater than resemblances in physical traits which could have been caused, in some cases, only by original nature.

The facts are easily, simply and completely explained by one simple hypothesis: namely, that the natures of the germ-cells—the conditions of conception—cause whatever similarities and differences exist in the original natures of men, that these conditions influence body and mind equally, and that in life the differences in modification of body and mind produced by such differences as obtain between the environments of present-day New York City public school children are slight.

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[3] The raw coefficient was .754. I have no means of correcting for attenuation except indirectly. The corrected coefficient would be at least .80.

[4] The correction for attenuation would increase this only slightly, since it is derived from seven trials. The true r can hardly be above .75.

[5] The case is as noted in note 4. The true r can hardly be above .85.

Certain other hypotheses seem possible at first sight, but become involved in great difficulties when one tries to explain all the facts by any of them. These difficulties I will point out briefly.

TABLE 4

The resemblances of twins in mental and in physical traits

In Mental Traits		In Physical Traits	
1. A test	.69	11. Cephalic index	.76
2. Word test	.71	12. Ht. sitting/ht.	.76
3. Misspelled	.80 +	13. Height	.78
4. Addition	.75	14. Height sitting	.83
5. Multiplication	.84	15. Circ. of head	.75
6. Opposites	.90	16. Width of head	.86
7. Combined mark in 1–3	.70 +	17. Arm length	.72
8. Combined mark in 4–6	.82 +	18. Finger length	.71

7, 8 and 12–15 are raw correlations and the correction for attenuation might raise them by .01 or .02.

Median of 1–6	.78	Average of 11–12	.76 (possibly .77)
		" 13–18	.77 (possibly .78 or .79)
Average of 1–6	.78	Median of 13–18	.77 (possibly .78 or .79)
		" 11–18	.76 (possibly .77)
Average of 7–8	.76 (possibly .80)	Average of 11–18	.76 (possibly .77)

It may be said that all that has been proved of the twins is that they are alike in general mental maturity (*i. e.*, in the points of development which they have reached).

Traits like those tested are of course influenced by maturity directly and indirectly through the relation between maturity and advance in school and the relation between the latter and certain of the traits tested. But maturity is by no means the total cause of efficiency in these traits. Nor is it a cause comparable in amount of influence with individual differences apart from maturity. Nor is there any evidence that there is any greater resemblance of twins in maturity than in other factors, such as eyesight. If maturity were the total cause of efficiency in the six traits measured, these traits should in the same individual show perfect correlation with each other. They do not, nor, indeed, enough correlation to assign maturity a very important place as a contributory cause. If resemblance in maturity were the cause of the resemblances found, these should be largest in the traits most subject to maturity. The opposite is the case.

It may be said that all that has been proved of the twins is that the environmental conditions from 9 to 14 years count little; that the similarities in environment *in utero* and during childhood are left as possible causes of the resemblances found; and that these are the real causes. But that the conditions *in utero* are the cause of the resemblances of related individuals is disproved by the fact that paternal is as great as maternal resemblance in the case of those traits where parents and offspring have been compared; and that similarities in environment from 0 to 9 years should produce a far greater effect on the children's abilities to add, multiply, mark misspelled words and write opposites than do similarities in environment from 9 to 15 is a notion utterly devoid of probability.

It is equally difficult to accept original nature as a cause of a moderate amount of the resemblance found and to explain the rest as due to training. Suppose, for instance, that some one assumes that the force of the germ-natures,—of the conditions of conception,—is sufficient to produce a resemblance of .20 in siblings and .40 in twins in mental traits. He must then be willing to believe that the likeness in training of a twin pair is enough greater than the likeness in training of a sibling pair, two or three years apart in age, to make the .40 rise to .80, whereas the .20 rises only to .40 or less. He must also be willing to believe either that inborn mental make-up is inherited by a totally different law from that regulating inborn physical make-up or else that the similarities in training of twins will raise .40 to .80 in physical traits such as cephalic index, and that the similarities in training of siblings will raise the .20 only to .40 or .50. He must also place the bulk of influence of this training previous to the tenth year and assume that it is of such a generalized sort as would raise the resemblances in marking A's or words containing *r* and *e* as much as that in multiplication.

Doubtless we all feel a repugnance to assigning so little efficacy to environmental forces as the facts of this study seem to demand; but common opinion also feels a repugnance to believing that the mental resemblances of twins, however caused, are as great as the physical resemblances. Yet they are. I can not here discuss the general facts and detailed studies which bear upon the question of the amount of influence of such likenesses and differences in environment as existed in the case of these twins.

I shall also spend but little time in comments upon the application of the facts so far presented to theories of education and human action and to the practical problems of social control. The inferences with respect to the enormous importance of original nature in determining the behavior and achievements of any man in comparison with his fellows of the same period of civilization and conditions of life are obvious. All theories of human life must accept as a first principle the fact that human beings at birth differ enormously in mental capacities and that these differences are largely due to similar differences in their ancestry. All attempts to change human nature must accept as their most important condition the limits set by original nature to each individual.

We must be careful, however, not to confuse two totally different things: (1) the power of the environment,—for instance, of schools, laws, books and social ideals,—to produce differences in the relative achievements of men, and (2) the power of the environment to produce differences in absolute achievement. It has been shown that the relative differences in certain mental traits which were found in these one hundred children are due almost entirely to differences in ancestry, not in training; but this does not in the least deny that better methods of training might improve all their achievements fifty per cent. or that the absence of training, say in spelling and arithmetic, might decrease the corresponding achievements to zero. Similarly, the fact that Mr. Rockefeller has amassed one of the great fortunes of the age is undoubtedly due almost exclusively to his original capacity, not to circumstances; but this does not deny that it is almost exclusively circumstances which make the average wealth of men to-day greater than it was a thousand years ago or that future changes in the environment might, without any change in capacity, make nine men out of ten the owners of automobiles, race-horses, tall hats and the other blessings of wealth.

The argument has been limited entirely to the causes which make one person differ from another in mental achievements *under the same general conditions of life at the beginning of the twentieth century in New York City as pupils in its school system.* If the resemblance of twins had been measured in the case of a group made up partly of New York City school children and partly of children of equal capacity brought up in the wilds of Africa, the variability of the group in addition and multiplication would have increased and the correlation coefficients would rise. They would then measure the influence of original nature plus the now much-increased influence of the environment.

The relative impotence of such similarities of home training as existed in our fifty pairs of twins to create similarities of achievement does, however, make one suspect that the magnitude of the influence of the training given by schools, periods of civilization and the like has been exaggerated. For other reasons, also, I imagine this to be the case, but to prove or disprove it, one would need data quite different from the records of these hundred twins.

It is, then, folly to conclude that the inheritance of mental capacities from immediate ancestry implies the futility of education and social control in general,—the wisdom of fatalism and *laissez faire*. Such studies as this merely prove the existence of and measure one determinant of human intellect and character and demonstrate that the influences of the environment are differential, the product varying not only in accord with the environmental force itself, but also in accord with the original nature upon which it operates. We may even expect that education will be doubly effective, once society recognizes the advantages given to some and denied to others by heredity. That men have different amounts of capacity does not imply any the less advantage from or need of wise investment. If it be true, for example, that the negro is by nature unintellectual and joyous, this does not imply that he may not be made more intelligent by wiser training or misanthropic and ugly-tempered by the treatment he now receives. It does mean that we should be stupid to expect the same results from him that we should from an especially intellectual race like the Jews, and that he will stand with equanimity a degree of disdain which a Celt would requite with dynamite and arson.

To the real work of man for man,—the increase of achievement through the improvement of the environment,—the influence of heredity offers no barrier. But to the popular demands from education and social reforms it does. For the common man does not much appreciate absolute happiness or absolute betterment. He does not rejoice that he and his children are healthier, happier and more supplied with noble pleasures than were his ancestors of a thousand years ago. His complaint is that he is not so well off as some of those about him; his pride is that he is above the common herd. The common man demands *relative* superiority,—to be above those of his own time and locality. If his son leads the community, he does not mind his real stupidity; to be the handsomest girl in the county is beauty enough. Social discontent comes from the knowledge or fancy that one is below others in welfare. The effort of children in school, of men in labor and of women in the home is, except as guided by the wise instincts of nature or more rarely by the wisdom of abstract thought, to rise above some one who seems higher. Thus the prizes which most men really seek are, after all, in large measure given or withheld by original nature. In the actual race of life, which is not to get ahead, but to get ahead of somebody, the chief determining factor is heredity.

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